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The $dp-$elastic cross section measurement at the deuteron kinetic energy of 2.5 GeV

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Abstract. New results on the differential cross section in deuteron-proton elastic scattering are obtained at the deuteron kinetic energy of 2.5 GeV with the HADES spectrometer. The angular range of 69° – 125° in the center of mass system is covered. The obtained results are compared with the relativistic multiple scattering model calculation using the

CD-Bonn deuteron wave function. The data at fixed scattering angles in the c.m. are in qualitative agreement with the constituent counting rules prediction.

1 Introduction

The study of deuteron-proton interaction, in particular at intermediate and high energies, solves the problem of deuteron internal structure and nucleon-nucleon interaction at small distances. Already at the energies of 0.25 GeV the Faddeev calculation cannot reproduce the dp-elastic cross section data at the large angles in the c.m. [1]. On the other hand, the relativistic multiple scattering model describes well the data on dp-elastic scattering at 0.88 GeV up to 110° [2]. At high energies and large transverse momenta the constituent counting rules (CCR) [3,4] predict a $1/s^{n-2}$ dependence of the differential cross section for the binary reaction, where n is the total number of the fundamental constituents involved in the reaction. A regime corresponding to CCR can occur already at $T_d = 500$ MeV [5].
In this paper we present new experimental data on the differential cross section for dp-elastic scattering at a deuteron beam kinetic energy of 2.5 GeV obtained with the HADES spectrometer [6].

2 Results and discussion

2.1 Experiment

HADES (High Acceptance Di−Electron Spectrometer) is located at GSI, Darmstadt and it is currently operated at the SIS18 synchrotron at beam energies of 1 − 2 GeV/u. It is a magnetic spectrometer which is capable to register $e+/e-$ particles in a polar angle ranges from 18° up to 85° and has almost full azimuthal coverage. Technical aspects of the detector are described in [6].
In the experiment presented the deuteron beam with a kinetic energy of $T_d = 2.5$ GeV and an intensity of about 10^7 particles/s was directed onto a 5 cm long liquid-hydrogen cell with a total areal thickness of $0.35 g/cm^2$. In order to investigate the np interaction using the deuteron beam the HADES setup was upgraded with a Forward Fall(FW) scintillator hodoscope.

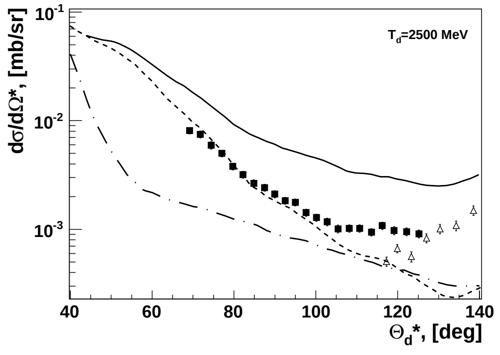

Fig. 1. The dp-elastic cross section data compared with the relativistic multiple scattering model calculation at 2.5 GeV. The HADES results are shown by the black squares. World pd−elastic scattering data at 1.3 GeV/nucleon [9] are presented by the open triangles. The curves are described in the text.

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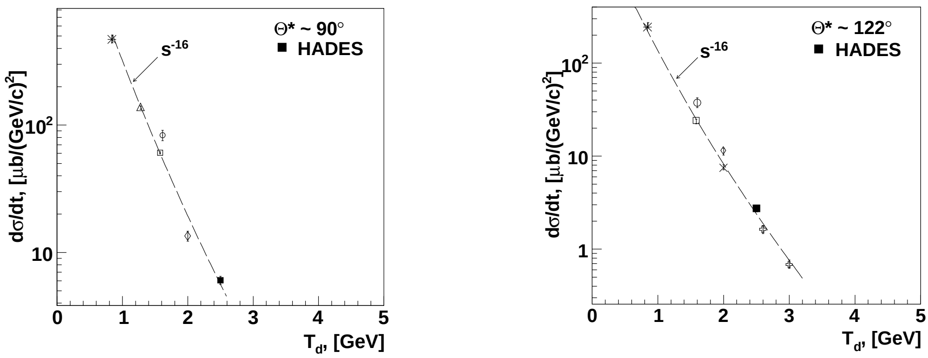

Fig. 2. Differential cross section of dp-elastic scattering at fixed scattering angle of 90° and 122° in c.m.s The HADES results are presented by the full square. The world data are marked by the open symbols. The curves are the predictions of constituent counting rules.

2.2 Results

Fig. 1 shows the result on the angular dependence of the $dp-$elastic cross section at $T_d = 2.5$ GeV compared with the relativistic multiple scattering model calculations [2, 7] using CD-Bonn deuteron wave function [8]. The dashed line corresponds to the calculations taking into account single scattering contributions only. The solid and dash-dotted curves are the results of calculation including the single and double scattering term with and without the principal value part of the three-nucleon free propagator, respectively. The deviations in the description of the angular dependence of the $dp-$elastic cross section data and theoretical calculations [2, 7] are observed. The results of the calculation taking into account only the single scattering term underestimate the cross section data, while including the double scattering leads to the experimental data overestimation. World $pd-$elastic scattering data at 1.3 GeV/nucleon [9] are presented by the open triangles.
The results on the differential cross section in dp-elastic scattering obtained at 2.5 GeV and fixed scattering angles in the c.m. are presented in Fig. 2. The HADES data are depicted by the full square. The world data[9–13] are shown by the open symbols and stars. The lines are the result of the fitting of the world data by the function $\sim s^{-16}$. The data at fixed scattering angles in the c.m. are in a qualitative agreement with the constituent counting rules prediction.

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